CLAIMS

What is claimed is:

1. A capillary electrophoresis system comprising:

a base;

a plurality of wells disposed on the base;

an arm assembly mounted to the base and movable in three dimensions;

a detector docking station mounted to the base; and

a detector module comprising a capillary extending from an inlet end to an outlet end, a pair of electrodes extending adjacent the capillary inlet end and the capillary outlet end, and a detector aligned with a portion of the capillary, the arm assembly operative to move the detector module from the detector docking station to a working position with the capillary inlet end and an associated electrode disposed in a selected well and the capillary outlet end and an associated electrode disposed in a corresponding selected well.

2. The system of claim 1, wherein said detector is an ultraviolet absorbance detector.

3. The system of claim 1, wherein said detector is a laser-induced fluorescence detector.

4. The system of claim 1 further comprising a microfluidic pipette mounted to the arm assembly for movement therewith.

5. The system of claim 1, further comprising a pipette wash station mounted on the base.

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6. The system of claim 4, wherein the arm assembly is operative to move said pipette to perform a sample preparation without affecting a running capillary electrophoresis analysis.

7. The system of claim 1, further comprising a plurality of detector modules, each detector module comprising a capillary extending from an inlet end to an outlet end, a pair of electrodes extending adjacent the capillary inlet end and the capillary outlet end, and a detector aligned with a portion of the capillary.

8. The system of claim 7, wherein the arm assembly is operative to move each of the plurality of detector modules individually from the detector docking station to a working position with the capillary inlet and an associated electrode disposed in a selected well and the capillary outlet end and an associated electrode disposed in a corresponding selected well.

9. The system of claim 1, wherein the capillary of the detector module comprises a glass tubing having an external polyimide coating thereon, a portion of the glass tubing free of the polyimide coating in a location to form a window in alignment with the detector on the detector module.

10. The system of claim 1, wherein the detector module further includes a removable cartridge component, a channel is formed in the removable cartridge component, and the capillary is laid in the channel.

11. The system of claim 1, wherein the detector module further comprises a latch mechanism configured to retain the removable cartridge component to an upper housing.

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12. The system of claim 11, wherein the upper housing is movably attached to the base.

13. The system of claim 1, wherein the detector module further comprises a pneumatic sealing element at the inlet end and at the outlet end operative to seal a respective capillary and associated electrode to a working well.

14. The system of claim 1, wherein the detector module further includes a temperature regulating mechanism operative to maintain the capillary at a selected temperature.

15. The system of claim 14, wherein the temperature regulating mechanism comprises a heat sink.

16. The system of claim 14, wherein the temperature regulating mechanism comprises a cooling channel formed in a portion of the detector module, a coolant circulatable through the cooling channel.

17. The system of claim 1, wherein the plurality of working wells is disposed on a plurality of microtiter plates.

18. The system of claim 17, wherein at least one of the plurality of microtiter plates comprises a control plate, and a plurality of wells containing control samples are provided on the control plate.

19. The system of claim 17, wherein at least one of the plurality of microtiter plates comprises a sample plate, and a plurality of wells containing unidentified samples are provided on the sample plate.

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20. The system of claim 17, wherein at least one of the plurality of microtiter plates comprises an inlet working plate and the arm assembly is operative to fill the working wells on the inlet working plate with an aliquot of sample.

21. The system of claim 17, wherein at least one of the plurality of microtiter plates comprises an outlet working plate and the working wells on the outlet working plate are disposed to receive an aliquot of sample.

22. The system of claim 17, wherein at least one of the plurality of microtiter plates comprises an inlet working plate, the selected well disposed on the inlet working plate, and at least a second of the plurality of microtiter plates comprises an outlet working plate, the corresponding selected well disposed on the outlet working plate.

23. The system of claim 22, wherein the inlet working plate and the outlet working plate are configured with a selected spacing between the selected well and the corresponding selected well, and the detector module is configured with a spacing between the capillary inlet end and the capillary outlet end to allow registration with the selected spacing between the selected well and the corresponding selected well.

24. The system of claim 1, wherein the arm assembly further comprises:

an X-arm extendable horizontally over the plurality of wells;

a Y-arm fixedly mounted to the base and extending horizontally along a side of the wells orthogonal to the X-arm, the Y-arm linearly movably mounted on the X-arm;

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a Z-arm extending vertically, the Z-arm linearly movably mounted on the Y-arm; and

a pick-up assembly movably mounted on the Z-arm for vertical motion.

25. The system of claim 24, further comprising a track mechanism disposed on the X-arm, the Y-arm movably mounted to travel along the track mechanism of the X-arm.

26. The system of claim 24, further comprising a track mechanism disposed on the Y-arm, the Z-arm movably mounted to travel along the track mechanism of the Y-arm.

27. The system of claim 24, further comprising a track mechanism disposed on the Z-arm, the pick-up assembly movably mounted to travel on the track mechanism of the Z-arm.

28. The system of claim 1, wherein the arm assembly further comprising a pick-up assembly configured to engage and retain the detector module to transport the detector module.

29. The system of claim 28, wherein the pick-up assembly includes a detector module retaining mechanism.

30. The system of claim 29, wherein the detector module includes a magnetizable element, and the retaining mechanism comprises an energizable magnetic assembly operative to engage the magnetizable element on the detector module.

31. The system of claim 30, wherein the magnetizable element comprises a steel plate.

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32. The system of claim 30, wherein the detector module includes a guide member for directing the magnetic assembly of the pick-up assembly to the magnetizable element.

33. The system of claim 1, wherein the detector docking station further comprises at least a pair of wells in registration with the capillary inlet end and the capillary outlet end to receive the capillary and the associated electrode extending from the inlet end and the capillary and the associated electrode extending from the outlet end.

34. The system of claim 33, wherein a buffer solution is disposed in the pair of wells on the detector docking station.

35. The system of claim 1, wherein the detector docking station further comprises a detector module hold-down mechanism.

36. The system of claim 35, wherein the detector docking station includes a magnetizable element, and the hold-down mechanism comprises an energizable magnetic assembly operative to engage the magnetizable element on the detector module.

37. The system of claim 1, further comprising a controller assembly in communication with the arm assembly and operative to direct the arm assembly to move a selected one of the plurality of detector modules to a selected position.

38. The system of claim 37, wherein the controller assembly further comprises a display device and an operator input device.

39. A method of establishing high throughput capillary electrophoresis analysis, said method comprising the steps of:

providing the system of claim 1;

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providing a sample for analysis; and

performing a capillary electrophoresis assay using the system of claim 1.

40. A detector module for cooperation with a capillary electrophoresis system comprising:

a housing having a channel therethrough;

a capillary disposed in the channel in the housing and extending from an inlet end to an outlet end;

a first electrode depending from the housing in association with the capillary at the inlet end and a second electrode depending from the housing in association with the capillary at the outlet end; and

a detector disposed in alignment with a portion of the capillary.

41. The detector module of claim 40, wherein the detector comprises an ultraviolet detector.

42. The detector module of claim 40, wherein the detector comprises a laser induced fluorescence detector.

43. The detector module of claim 40, wherein the detector module further comprises a temperature regulating mechanism operative to maintain the capillary at a selected temperature.

44. The detector module of claim 43, wherein the temperature regulating mechanism further comprises a cooling channel formed in the housing for a coolant to circulate in the coolant channel.

45. The detector module of claim 43, wherein the temperature regulating mechanism further comprises a heat sink.

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46. The detector module of claim 40, wherein the detector module further comprises a sealing element at the inlet end and the outlet end operative to seal a respective capillary and associated electrode to a working well.

47. The detector module of claim 46, wherein the sealing element is an O-ring.

48. The detector module of claim 40, wherein detector module further comprises a mechanism configured to be lifted by an arm assembly of a capillary electrophoresis system.

49. The detector module of claim 48, wherein a liftable mechanism configured to be lifted comprises a magnetizable plate.

50. The detector module of claim 42, further comprising an input optical fiber disposed to transmit light from a laser source having a termination adjacent a capillary disposed in the channel to direct light through the capillary at an acute angle to an axial extent of the capillary.

51. The detector module of claim 50, wherein the acute angle is greater than a critical angle at which light is reflected away from the capillary.

52. The detector module of claim 50, further comprising a chamber disposed in the housing on an opposite of the capillary from the termination of the optical fiber and in axial alignment with the optical fiber.

53. The detector module of claim 42, further comprising an input excitation light path, the excitation light path defining an excitation light axis crossing the capillary and a collection

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TEL. (617) 542-2290
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optical assembly defining a collection optical axis, the excitation axis and the collection optical axis disposed orthogonally.

54. The detector module of claim 53, the collection optical assembly comprising an objective lens assembly configured to maximize an angle of light collection from the capillary.

55. The detector module of claim 54, wherein the objective lens assembly is configured to direct light from the capillary onto substantially parallel paths.

56. The detector module of claim 53, wherein the optical collection assembly further includes an interference filter configured to block excitation energy and to pass fluorescent energy.

57. The detector module of claim 53, wherein the optical collection assembly further comprises a focusing lens disposed to create an image from the capillary.

58. The detector module of claim 53, wherein the optical collection assembly further comprises a mask configured to prevent passage of extraneous sources of light.

59. The detector module of claim 42, further comprising a photomultiplier tube sensor aligned on the axis of the collection assembly.

60. The detector module of claim 41, wherein the ultraviolet detector further comprises an optical fiber in communication with an ultraviolet light source and having a termination disposed adjacent to the capillary in the housing, and a photodiode

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disposed on an opposite side of the capillary in alignment with the termination of the optical fiber.

61. The detector module of claim 60, further comprising an amplifier element in communication with the photodiode.

62. The detector module of claim 61, wherein the amplifier element and photodiode are disposed in a shielded cavity

63. The detector module of claim 62, wherein a conductive coating is disposed on wall surfaces of the cavity.

64. The detector module of claim 60, wherein the photodiode and the amplifier element is disposed in a removable portion of the housing.

65. The detector module of claim 64, further comprising a connector disposed on the removable portion of the housing for connection to a cooperative portion of the housing.

66. The detector module of claim 40, wherein the housing further includes a removable cartridge, the capillary, the first electrode, the second electrode are mounted to the removable cartridge.

67. A capillary electrophoresis system comprising:

a base;

a plurality of wells disposed on the base;

an arm assembly mounted to the base and movable in three dimensions;

a detector docking station mounted to the base, a pair of electrodes are disposed on the docking station; and

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a detector module comprising a capillary extending from an inlet end to an outlet end, and a detector aligned with a portion of the capillary, the arm assembly operative to move the detector module from the detector docking station to a working position with the capillary inlet end disposed in a selected well and the capillary outlet end disposed in a corresponding selected well.

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GAGNEBIN & LEBOVICI LLP
TEL. (617) 542-2290
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